Knowledge grows

Our Position on Regenerative Agriculture

May 2023

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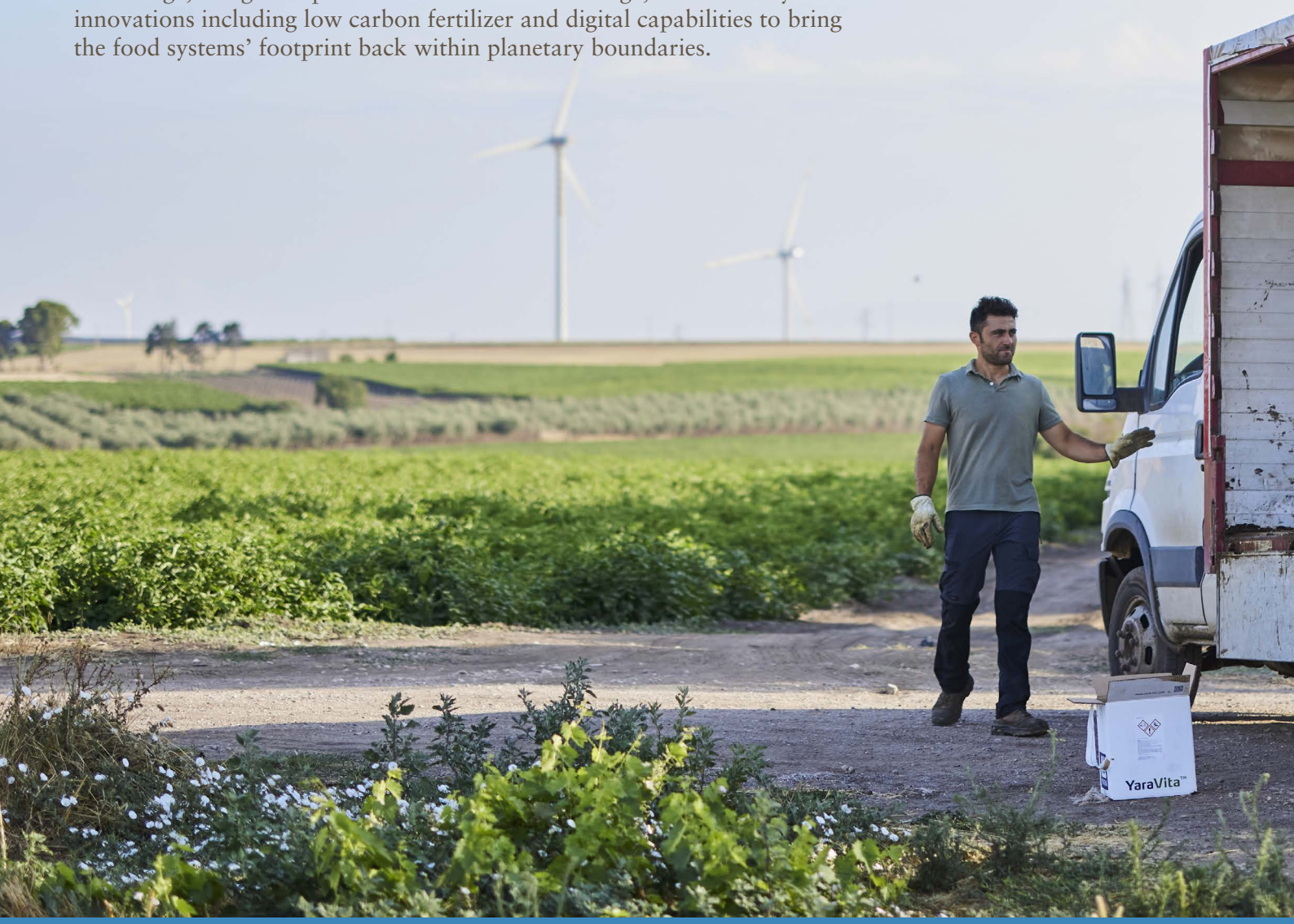
Executive Summary

International agreements and scientific studies on climate and nature lay the foundations for a shift to regenerative agriculture. Yara supports the implementation of regenerative agriculture according to our definition of it as a ***"systematic, outcome-based approach to adopt the best sustainable farming practices that positively affect nature and climate, across five recurrent themes: climate, soil health, resource use efficiency, biodiversity, and prosperity"***.

We believe that balanced crop nutrition is a critical contribution to scaling up regenerative outcomes in the food sector and to reach the targets of international agreements. Yara's products and services help farmers and value chain players to transition into regenerative farming and opens wide-ranging opportunities to innovate and accelerate progress.

Yara is committed to work alongside other frontrunners to achieve common goals. We are ready to leverage our over hundred years of plant nutrition knowledge, our global presence and market knowledge, reinforced by our innovations including low carbon fertilizer and digital capabilities to bring the food systems' footprint back within planetary boundaries.



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Background

The Paris Climate Agreement 2015 and the ***Kunming-Montréal Global Biodiversity Framework 2022*** set the direction for rapid and far-reaching systems transitions to address the climate and nature crises as the most pressing challenges of our times.

We believe there is no option but to place climate and nature first, and that the agrifood sector, including the fertilizer industry, must support nature regaining a sustainable balance. The agreements provide the framework to reach Yara's overarching ambition to Grow a Nature–Positive Food Future.

Reducing the agrifood industry's impacts on planetary boundaries - including the nitrogen and phosphorus cycles, biodiversity, and greenhouse gas emissions[1] - are critical in achieving the global targets. Doing so also brings opportunities to build healthier, more sustainable, efficient and equitable food systems[2] and the agrifood industry is pivotal in improving soil health, optimizing the use of precious natural resources, improving nutritional quality of crops to support consumer health, and paying farmers fairly. It will require a consolidated, joint effort by everyone – companies, governments, experts, NGOs, farmers and consumers – to implement the global frameworks and drive the paradigm shift where our relationship to land and nature is re-valued and the externalities of the agrifood industry are include in the total cost of production and consumption.

Regenerative agriculture has emerged as an approach[3] that – adopted to local challenges and with adapted methods – can be scaled up to:

- grow sufficient, nutritious food on current agricultural land to ensure food security for the world's population;
- create positive externalities including improved agricultural soils, watersheds, biodiversity and other nature-positive ecosystem outcomes;
- limit global warming to 1.5°C above pre-industrial levels by reducing the carbon footprint of farming and contributing to soil carbon sequestration; and
- improve the livelihoods of the world's 600 million farmers.

We believe regenerative agriculture has a huge potential to act as a lever both to mitigate and adapt to the climate crisis and contribute decisively to create a nature-positive food future. We believe it is possible, and we are already taking steps to make it a reality.

What is regenerative agriculture?

Regenerative agriculture is an evolving, science-based, outcome-focused farming approach that aims to reduce the food value chain's negative impacts on climate and nature while increasing those that drive sustainability, productivity, and quality.

Regenerative agriculture is broader and less prescriptive than other approaches, methods and terms used for much of the same purposes, such as agroecology, and organic, conservation, precision and carbon farming. It is more inclusive to all farmers and practices that lead to regenerative outcomes, including a targeted and optimized use of mineral fertilizers.[4] It aims to maintain agricultural productivity in addition to achieving ecological benefits such as restoring soil biodiversity and enhancing ecosystem services including carbon capture and storage, and – importantly – regenerative agriculture can be scaled while at the same time feeding the world's growing population.

There is currently no commonly agreed definition or targets, but there is convergence on the principles and nature-positive outcomes of regenerative agriculture. In other words, there is increasing alignment on "what" the new paradigm must achieve (the outcomes), but as every region and every farm is unique, "how" to get there (the practices) is left to each farmer to adapt based on available tools, technologies and inputs tailored to the specific context. There is ongoing work to agree common quantifiable metrics so that all value chain players can support and finance the transition[5]. Yara is actively participating, with our crop nutrition knowledge, in co-development of the framework.

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Definitions of Regenerative Agriculture

Since 2019, Yara has been working with sector coalitions to align on working definitions, including these serving as examples of an evolving process and approach:

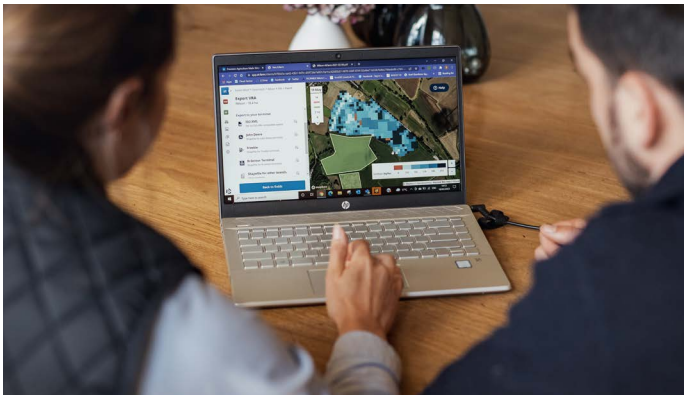
- "Regenerative agriculture is an adaptive outcome-based farming approach that delivers positive impact on soil health, climate, biodiversity, water to ensure yield resilience and sustain good farmer livelihoods."
  The Food Collective
- "Regenerative agriculture is a holistic land management system that simultaneously promotes above- and below-ground carbon sequestration, reduces greenhouse gas emissions, protects and enhances biodiversity in and around farms, improves water retention in the soil, improves nutrient use efficiency, and supports farming livelihoods."
  One Planet Business for Biodiversity (OP2B hosted by WBCSD)
- "Regenerative agriculture is an outcome-based farming approach that protects and improves soil health, biodiversity, climate, and water resources while supporting farming business development."
  SAI Platform's Regenerative Agriculture Project

Yara defines regenerative agriculture as a ***"systematic, outcome-based approach to adopt the best sustainable farming practices that positively affect nature and climate, across five recurrent themes: climate, soil health, resource use efficiency, biodiversity, and prosperity".***

Given the urgency outlined in the international agreements mentioned above, the lack of a perfect definition should not hold back work to improve soil health, resource use efficiency, biodiversity, farmer prosperity and addressing the climate crisis. Awareness of our ***impact and dependency*** on nature gives us the confidence – and sense of urgency – to speed up implementation of an industry-wide transformation: The agreed ***principles*** are sufficient to create a common ***direction*** and enable farmers and companies to innovate and implement solutions.

The role of crop nutrition in regenerative agriculture

Balanced and precise crop nutrition, whether from organic or mineral sources, is essential in scaling up regenerative agriculture while maintaining regional and global food security. Yara is of the firm conviction that the positive impacts of balanced crop nutrition management by far outweigh any unavoidable negatives from such an intervention. We always advocate that nutrients are applied and managed precisely, as a part of a bundle of adapted best practices, digital services, using lower carbon and fossil free products to optimize the overall outcomes with regards to both climate and nature. Wherever possible and economically feasible, we recommend integrating crop and livestock systems and apply adequate amounts of organic biomass and other nutrients to achieve the required balanced crop nutrition. This should ideally include both organic and lower carbon or green mineral fertilizers in order to maintain or increase crop growth and contribute to the nutrition of soil organisms and the soil organic content vital to soil health.



Targeted and optimized use of mineral fertilizer on agricultural soil is also required to ensure that a sufficient quantity and quality of food is produced, and natural land is safeguarded from being converted to agriculture. Each harvest contains plant nutrients such as nitrogen, phosphorus and potassium, which are removed from the agricultural fields and used for human and animal nutrition through the plants harvested. Only a fraction of these nutrients is recycled back to agricultural fields in organic material such as manure or compost. If the predominant non-recycled portion is not replaced by fertilizer, agricultural soils will be depleted of plant nutrients leading to declining yields and soil fertility. Mineral and organic sources of plant nutrients are complementary and need to be used in crop production in an integrated manner. Used in the right quantities and forms, they are both needed to provide safe, affordable and sustainable food to the end consumer.

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Yara advocates for nutrient management systems and tools designed to achieve better fertilizer use efficiency, where fertilizer demand is calculated based on soil analysis, yield expectations, desired crop quality and climate. We firmly endorse that organic nutrients available at a farm should be used first. Mineral fertilizers should then be added based on the calculated nutrient gap and applied according to best practice guidelines for the choice of product and application method.

If regenerative farms manage their agricultural soil through balanced crop nutrition and fertilization practices adapted to local conditions, there are several positive outcomes[6]:

- ***Increased agricultural output*** optimizing land use efficiency and ensuring food security.
- ***Increased crop resilience to climate stress*** thanks to improved nutrient availability in the soil and better crop quality.
- ***Improved soil fertility and soil health*** through improved plant growth, more organic matter is recycled into the field, improving soil structure, nutrient supply to soil micro-organisms, and soil organic carbon content and sequestration.[7]
- ***Reduced carbon footprint*** as optimizing nutrient management increases yields reduces in-field emissions per unit of crop produced, and a higher nutrient availability leads to lower nutrient losses.
- ***Reduced stress on freshwater reserves*** as well-nourished plants increase water use efficiency and provide more shadow cover to the soil, and efficient nutrient management reduces leaching.
- ***Reduced pressure towards land use change, deforestation and biodiversity loss in nearby zones***, given local structural and political support, due to higher productivity from existing agricultural land.
- ***Improved human health*** as the mineral nutrition applied to grow agricultural crops and pastures strongly affects the nutritional quality of food as well as biodiversity, both of which are essential to human well-being.

Adopting regenerative farming at scale

Yara strongly supports the notion that farmers themselves are at the core of the transformation to regenerative farming. Farmers carry most of the risk and cost[8] in changing the way food is produced, but we all need to be involved in creating a market that encourages and enables regenerative farming. To incentivize the change, the entire food ecosystem must make changes to ensure that farmers' business models remain feasible and profitable.

As the food system shifts from valuing just "the crop" to "the crop and ecosystem services" (healthy soil, clean water, biodiversity, carbon capture), it follows that the risks and costs involved, and the value created are redistributed fairly. Economic incentives for farmers are crucial. These may include mechanisms such as crop price premiums, additional revenue streams from new business models[9] and improved resource efficiencies, and government subsidies and investments in infrastructure. We must also act long-term to increase farmer resilience through market volatilities and climate events, for example through long-term contracts and insurance schemes.

Measurable indicators of progress must be agreed to reward farmers for regenerative outcomes, although some elements of progress are currently difficult to measure. Yara supports the use of management-based schemes,[10] for example no-/low-tilling for improved soil health and soil carbon sequestration. We also advocate for these metrics being farmer-friendly, i.e. obtainable with minimum additional labor and cost.

There is still work to do to align on indicators, but perfection is not necessary to start measuring progress on priorities identified in the Paris and Kunming-Montréal targets, and there are some "no regret moves" such as measuring Nitrogen Use Efficiency (NUE) and managing crop nutrition sustainably. These should be implemented immediately.

Yara's outcome-based indicators

Yara advocates for a set of outcome-based indicators showing net-positive changes over time, and we have identified the following as key drivers for change. We are developing digital tools to measure many of these indicators, and some can already be implemented at farmgate[11].

To mitigate emissions and improve crop resilience

- Product carbon footprint at farm gate: CO_2eq / T of crop
- Absolute farm GHG emissions: CO_2 eq. / ha
- Monitor carbon stock increase/ carbon gains: Soil Organic Carbon (SOC) t / ha

To improve soil fertility, soil structure, biodiversity and prevent soil degradation

- Soil chemical composition: pH, mineral nutrients content, soil organic matter
- Soil physical structure: Compaction, water infiltration rate, soil aggregates stability
- Time span of bare soil or soil without cover crop: Days in a year
- Percentage of fields with minimum-tillage cultivations: % of farmland
- General soil health: Soil Health Assessment Score

The efficient use of all necessary resources required for crop growth

- Yield: T of crop / ha
- Nitrogen use efficiency: N removal / N input x 100 (%)
- Water use efficiency for irrigated farm: T of crop / m^3 of water
- Land use efficiency: ha / t of crop; extra T of crop / ha vs. baseline
- Share of recycled nutrients in use: % recycled nutrients in total nutrients used on farm

To reduce pressure on land use change and to protect natural habitat

- Number of crop species in the production system: No. / ha / rotation
- Land use efficiency: ha / t of crop; extra T of crop / ha vs. baseline

To improve farmer livelihood

- Farmer (smallholder) productivity and profit per ha or per field: Return on Investment

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How does Yara contribute to scaling regenerative agriculture?

Yara is committed to working with farmers, food companies, multilateral organizations and governments to achieve ambitious regenerative targets. Our solutions offering enables farmers to account for every nutrient through precise nutrient and soil management, complementing nutrients already found in the local production system to grow crops to their full potential.

We advocate for crop nutrition products to be customized to the context (considering specificities such as crop, farm size, and region), as a part of a holistic approach that includes precision tools, digital tools, and agronomic advice to drive regenerative outcomes adapted to each farming landscape. With our deep agronomic knowledge, low carbon and organic-based products and digital technologies, we support farmers to adopt and implement science-based practices.

Over the last decade, Yara has invested in cutting-edge solutions to support best nutrient and soil management practice. We are committed to develop new tools, services and collaborations in addition to those below aimed at providing a good starting point for regenerative farmers and food chains alike and already available:

- ***Improving Nutrient Use Management*** through agronomic advice to achieve balanced crop nutrition, delivering higher crop quality/marketable yield with optimum and often lower resource use. Our nitrate-based product range has an efficiency superior to ammoniacal-based solutions, enabling better crop growth leading to better biomass production and higher crop yield.
- ***Digital farming solutions like*** Atfarm, N-Sensor, Adapt-N improve resource use efficiency with positive impacts on climate, nature and food security.
- ***Soil health analytics*** like Megalab™, a web-based biometric data interpretation service integrated with laboratories around the world, provides knowledge on chemical, physical and biological indicators to benchmark against Yara's Soil Health Index and support decision-making on crop and soil management strategies.
- ***Fossil-free green nitrate-based fertilizers***, produced by electrolyzing water and using only renewable electricity in the production processes, have a carbon footprint approximately 80% lower than conventional fertilizers, and all nitrates are produced with Yara's catalyst cleaning technology. Using these fossil-free green fertilizers reduces the product carbon footprint of many crops with up to 30% and many food products with up to 20% versus conventional fertilizers.
- ***Lower-carbon nitrate-based fertilizers*** are nitrates produced from hydrogen/ammonia at plants with N_2O abatement catalyst installed. A Carbon Footprint Management Program verifies that our customers receive up-to-date Product Carbon Footprints. Efficient N_2O cleaning reduces the CO_2eq. product carbon footprint of the nitrates by approximately half.
- ***Blue fertilizers*** are produced like lower-carbon fertilizer with N_2O cleaning, and in addition the CO_2 emitted during production is captured and stored. The product carbon footprint is reduced by 60%–90% relative to ammonia.
- ***Organic-based fertilizers*** include organic fertilizers derived from mainly plant or animal materials[12], and organo-mineral fertilizers optimizing inorganic and organic materials tailored to crop requirements. Our organic-based products contribute to a circular economy by recycling nutrients back to the field, improve soil health and crop resilience and increase soil organic matter (carbon and nutrients) and yields. Examples include YaraSuna, YaraNature and the new grades from the London pilot of the Nutrient Upcycling Alliance valorising local food waste to create organo-mineral fertilizers for use on local farms.
- ***Plant Biostimulants*** like BIOTRYG, to stimulate natural processes enhancing plant nutrient uptake, nutrient use efficiency, tolerance to abiotic stress and crop quality.
- ***Foliar applications*** of macro- and micronutrients such as YaraVita Foliar Nutrition to complement soil nutrition at critical crop growth periods.
- ***Carbon Farming*** through Agoro Carbon Alliance to incentivise farmers to capture carbon in soil.
- Field-level data sharing through platforms like Varda to accelerate the transition towards a nature-positive food system.
- ***Fertigation fertilizer and precision irrigation*** such as YaraRega and YaraTera CALCINIT, to improve efficiencies in water and fertilizer use, increasing yield and reducing the need for more agricultural land.

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References and footnotes

[1] Agriculture production as a major driver of the Earth system exceeding planetary boundaries, Ecology and Society, Vol. 22, No. 4, Campbell et al (2017); Planetary boundaries: Guiding human development on a changing planet, Science, Steffen et al (2015); IPBES 2019 Report (S. Díaz et al., Science 366, eaax3100 (2019)

[2] Growing Better: Ten Critical Transitions to Transform Food and Land Use, The Food and Land Use Coalition (2019)

[3] The Case for Regenerative Agriculture in Germany and Beyond; Food System Investments Are Key Climate, Biodiversity Solutions (nature.org) ; Regenerative Agriculture: An agronomic perspective - Ken E Giller, Renske Hijbeek, Jens A Andersson, James Sumberg, 2021

[4] Regenerative agriculture in Europe | European Academies' Science Advisory Council (EASAC) - Science Advice for the Benefit of Europe, https://easac.eu/publications/details/regenerative-agriculture-in-europe, April 2022, p.11

[5] Civil society, industry and governments are working together to define implementation steps through frameworks such as Science-based Targets Network and the Taskforce on Nature-related Financial Disclosures.

[6] Achieving Nature-positive plant nutrition: fertilizers and biodiversity, Scientific Panel on Responsible Plant Nutrition; Issue Brief 02, August 2021

[7] Arable soil has generally a lower carbon content than non-agricultural land; however when arable soil is fertilized, soil organic carbon is higher than soil without fertilizer.

[8] Cost of adoption, maintenance and reporting is higher in regenerative farming.

[9] E.g. a premium price for higher nutrient density or reduced carbon footprint of food; payment for ecosystem services such as improving soil and water quality, carbon sequestration, support for biodiversity and cultural services

[10] where practices and principles act as proxies for positive outcomes

[11] Through tools such as the Cool Farm Tool and MegaLab

[12] Raw materials include manure, by-products from meat and fish processing industries, agricultural residues, green waste, recycled bio-waste such as compost or digestate from food waste.

About Yara

Yara grows knowledge to responsibly feed the world and protect the planet. Supporting our vision of a world without hunger and a planet respected, we pursue a strategy of sustainable value growth, promoting climate-friendly crop nutrition and zero-emission energy solutions. Yara's ambition is focused on growing a nature positive food future that creates value for our customers, shareholders and society at large and delivers a more sustainable food value chain.

To achieve our ambition, we have taken the lead in developing digital farming tools for precision farming, and work closely with partners throughout the food value chain to improve the efficiency and sustainability of food production. Through our focus on clean ammonia production, we aim to enable the hydrogen economy, driving a green transition of shipping, fertilizer production and other energy intensive industries.

Founded in 1905 to solve the emerging famine in Europe, Yara has established a unique position as the industry's only global crop nutrition company. We operate an integrated business model with around 17,000 employees and operations in over 60 countries.

www.yara.com

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